LANDSCAPE RESEARCH

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Spatial distribution of perceived cultural ecosystem services in different land cover infrastructure types in urban and rural areas – case Kokemäki area, Finland

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This study aims to identify and evaluate the spatial distribution of Cultural Ecosystem Services (CES) benefits perceived by people in both urban and rural areas. A public participation GIS (PPGIS) approach was applied with local people who responded to an online survey and mapped their important places related to CES benefits in the Kokemäenjoki area. We explore the perceived ecosystem services of the community using different infrastructure types (green, grey, yellow and blue) based on the Corine Land Cover (CLC) classes. We identified spatial patterns of mapped important places using kernel density estimation and related CES benefit associations with the infrastructures using chi-square residuals. We found that CES in urban areas are provided more often when there is more than one type of infrastructure (e.g. grey and green; grey and blue), but grey infrastructures are preferred in urban areas, while blue infrastructures produce more CES benefits in rural areas.

Keywords: Ecosystem services; land cover; infrastructures; participatory mapping; PPGIS; Finland

Introduction

Ecosystem service, as a concept, has gained increasing attention among scientists and decision makers since the publication of the Millennium Ecosystem Assessment, which illustrates the complex dependencies between natural environments and human well-being (Mea, 2005). However, ‘ecosystem services’ requires a clear and logical definition (Ahtiainen & Öhman, 2014). Several studies (Berghöfer et al., 2011; Costanza et al., 1997; Daily, 1997; Haines-Young & Potschin, 2013; Mea, 2005) have defined it in the literature as, for example, the ‘benefits that people obtain from an ecosystem’; however, the definition needs to specify the functions of the ecosystem and its effects on human well-being. Hence, more recent research defines ecosystem services as associations of ecosystem function and physical structure with a combination of other related inputs for human well-being (Burkhard et al., 2012, 2018). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Regional Assessment in Europe and Central Asia also revealed the dynamic relationships between nature's contributions to people, biodiversity and ecosystems, and their relevance for human quality of life (Martín-López et al., 2018).

It is now broadly realised that ecosystem services are co-produced not only by ecosystem functions alone but also by their interactions with local social systems (Eigenbrod, 2016; Meacham et al., 2016; Reyers et al., 2013). This brings attention to assessing ecosystem services in relation to various land uses, which connect to different human activities, for example along the urban–rural gradient, in order to integrate ecosystem services into the planning process. Bonilla-Bedoya et al. (2020) have developed new tools and techniques along the urban–rural gradient by using different metrics and indexes related to building social environment and landscape characteristics. Rural and urban areas are both unique in terms of their ecological, social and environmental features. Rural areas are dominated by natural environments like pastures, agricultural areas, forests and natural green areas, and they typically include only small human settlements. Urban areas are characterised by built-up areas like densely populated settlements and artificial surfaces, but they also include nature, such as urban parks and forests (Gebre & Gebremedhin, 2019; Von Braun, 2007). Researchers and policy makers can overlook the contribution of the urban and rural areas in terms of providing benefits to each other.

There is growing interest in measuring ecosystem services in the urban–rural context (Chen et al., 2019; Soto-Montes-de-Oca et al., 2020; Zhu et al., 2017). It is essential to evaluate which ecosystem services are typical for different land use types to further develop ecosystem service-based planning in the urban–rural gradient (Koschke et al., 2012). Several studies have made these evaluations, mainly by using biophysical ecological data (Felipe-Lucia & Comín, 2015; Lilburne et al., 2020) such as land use/land cover or social-cultural data (Zhang & Ramírez, 2019) using survey or land-based approaches with statistical analysis. However, most of these studies address land use changes rather than ecosystem services provided by different land use and land cover types. Burkhard et al. (2009) and Koschke et al. (2012) measure the provision of ecosystem services in different land cover classes: Broadly, mixed and coniferous forests have been shown to provide provisioning, regulating and cultural services. Provisioning services are also provided by different kinds of agricultural areas and coastal landscapes, while regulating services are linked to water bodies. Burkhard et al. (2009) and Koschke et al. (2012) have also noticed that forests could provide multiple services. In their research, provisioning services are mostly provided by plantation areas and pastures. Regulating services are quite common in all land use types except urban areas. Cultural services are also provided in different environments like urban areas, water bodies, grasslands and pastures.

Different types of land uses like green areas (such as forests, shrub and/or herbaceous vegetation, and urban green areas) can be characterised with the term ‘infrastructure’. In recent years, green infrastructure has become important in land use sustainability planning (Hansen & Pauleit, 2014). Recently, ecosystem service studies have become related to different infrastructures, especially green infrastructure, which provides ecosystem services that improve the well-being of both nature and people (Dipeolu & Ibem, 2020). In addition to green infrastructure, similar terminology can also be applied to other land cover types to describe their large-scale distribution. Arable lands, permanent crops, pastures and heterogeneous agricultural areas can be identified as yellow infrastructure; water bodies and wetlands as blue; and built-up areas as grey infrastructure, respectively. Blue and green infrastructures can be considered as ecological infrastructures in ecosystem service–related studies, which try to focus on the importance of infrastructures for identifying ecosystems goods and services spatially (Kati & Jari, 2016; Li et al., 2017). Although no research has used the term ‘yellow infrastructure’, it can be applied to represent agricultural areas (Egoh et al., 2011; Lin et al., 2015; Qiu & Turner, 2013). In urban areas, grey infrastructure is studied more than green infrastructure, and some research deals with the integration of green-grey infrastructures to improve well-being (Svendsen et al., 2012). Infrastructure and ecosystem services concepts have the potential to improve landscape planning in urban areas and provide tools for the more holistic assessment of complex interrelations and dynamics of social–ecological systems (Hansen & Pauleit, 2014).

However, applying the ecosystem service concept at the landscape level is challenging because particularly the assessment of cultural ecosystem services (CES) such as aesthetic values, recreation and tourism requires more specific data on landscape character and landscape identity, as well as on non-material landscape benefits (Bachi et al., 2020; Bieling & Plieninger, 2013; Burkhard et al., 2009; Kaymaz, 2013; Small et al., 2017). As introduced by the European Landscape Convention, ‘landscape’ refers to ‘an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors’ (CoE, 2000). The Convention identifies landscape as an important component to understand all aspects of human life in all areas (Jones, 2007). Analysing landscape structure with its natural and cultural elements is important for bridging the gap between humans and nature; it is an effective way of explaining landscape characteristics related to ecosystems and, hence, to deliver ecosystem services (Ko & Son, 2018; Ramyar, 2019). Therefore, to provide sustainable landscape planning and management, analysing the landscape's physical features together with its social values is crucial (De Groot, 2006; Fagerholm et al., 2019). At this point, participatory research could be a key element for representing people's perceptions on the benefits of ecosystem services in a place-based way.

Participatory research aims to represent the knowledge of local communities and improve public involvement (Sieber, 2006; Kenter, 2016; Ridding et al., 2018), and it is a way of collecting perceptions of landscape and ecosystem services (Herlihy & Knapp, 2003). Additionally, it aims to aid decision makers in understanding how people perceive different landscape values linked to human well-being (Elwell et al., 2018; Battisti et al., 2019). Participatory approaches generally promote the understanding of the stakeholders' and communities' knowledge, perceptions and preferences about their living area or environment (Fagerholm et al., 2016; Villamor et al., 2014). Participatory mapping has become common in science and practice (Brown, 2013; Brown & Fagerholm, 2015; Brown & Kyttä, 2014a; Fagerholm et al., 2016; Garcia-Martin et al., 2017). Often called Participatory Geographical Information System or Public Participatory Geographical Information System (PGIS/PPGIS), participatory mapping approaches enable the collection of people's perceptions, values and interests in a place-based way. There is increasing academic and governmental interest in using participatory mapping technologies for decision-making and planning processes. In recent years, participatory mapping has also been used to identify and map ecosystem services (Brown, 2012; Brown & Fagerholm, 2015). However, studies have focused either on the rural (Fagerholm et al., 2016; García-Nieto et al., 2015) or urban (Ko & Son, 2018; Rall et al., 2017; Zhang & Ramírez, 2019) context, and there is limited understanding in assessing ecosystem services in the urban–rural gradient or in relation to different infrastructure types (Palomo-Campesino et al., 2018).

The main purpose of this study is to identify and evaluate the spatial distribution of CES perceived by local people in both the urban and rural areas of the Kokemäenjoki area (Southwest Finland, Fig 1). Local Kokemäenjoki residents responded to an online survey and mapped their important places related to different CES in their daily landscape. We explore the perceived ecosystem services of the community in relation to different infrastructure types. We aim to produce information on the CES provided by the study area and promote their acknowledgement in landscape planning. The more specific research questions are:

- What are the most common land cover infrastructure types (blue, green, yellow, grey) in rural and urban areas in the Kokemäki area, and what is the spatial distribution of important places in them?
- What types of CES benefits are perceived in each infrastructure type across rural and urban areas?

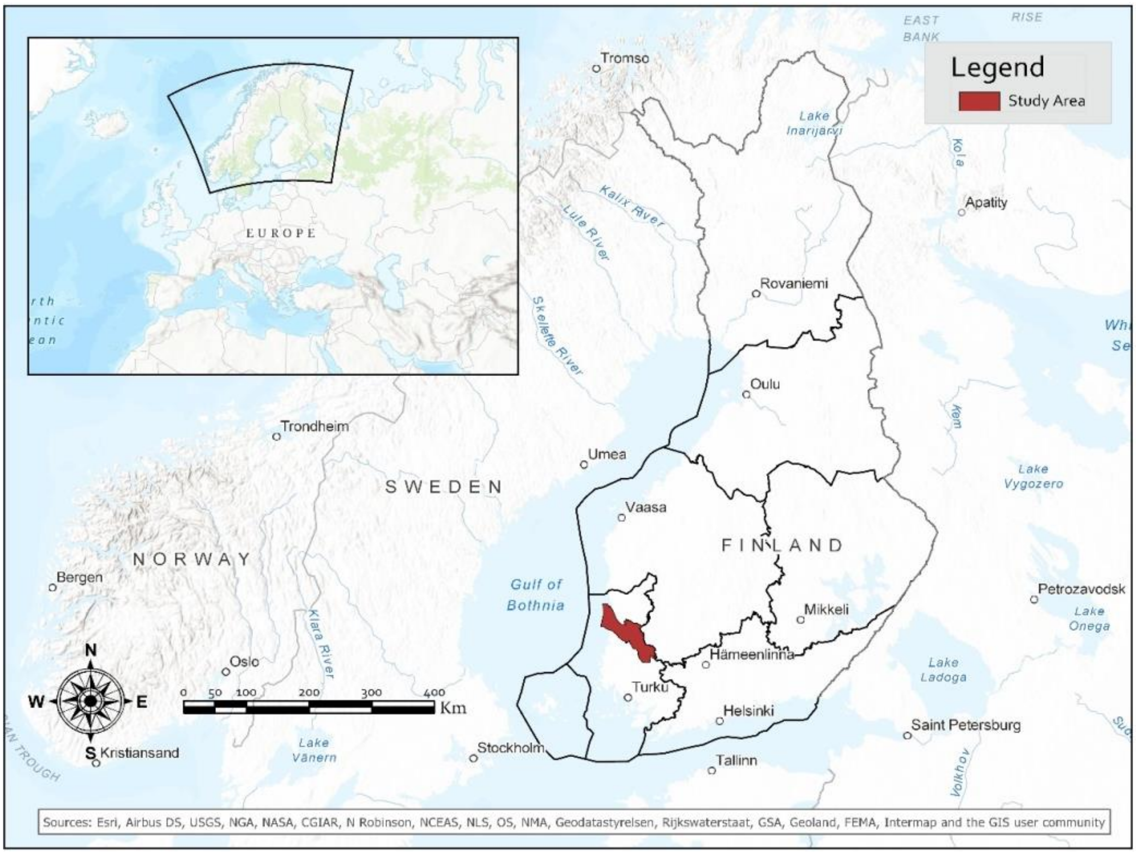
Finally, we discuss the relevance of the results for landscape planning and management, particularly in terms of the different infrastructures in rural and urban areas.

Materials and Methods

2.1 Study area

This study is performed along an urban–rural gradient in the Kokemäki River Basin located in Southwest Finland. Our study area (approximately 2,900 km^2) covers a wide array of natural and agricultural environments located along the river catchment. Human population in the river basin is concentrated along the main river channel. The biggest population centres are Pori (84.318 inhabitants), Ulvila (13,009 inhabitants), Harjavalta (7,006 inhabitants), Kokemäki (7,226 inhabitants), and Huittinen (10,075 inhabitants)

(OSF, 2020) (Figure 1). Kokemäenjoki, which discharges to the Bothnian Sea, is the longest river for this area. It has been widely used for transportation, irrigation and energy production, and many historical places are also linked to the river. Some parts of the study area have high-level human pressure because of urbanisation and other related reasons such as seasonal tourism destinations along the shoreline.



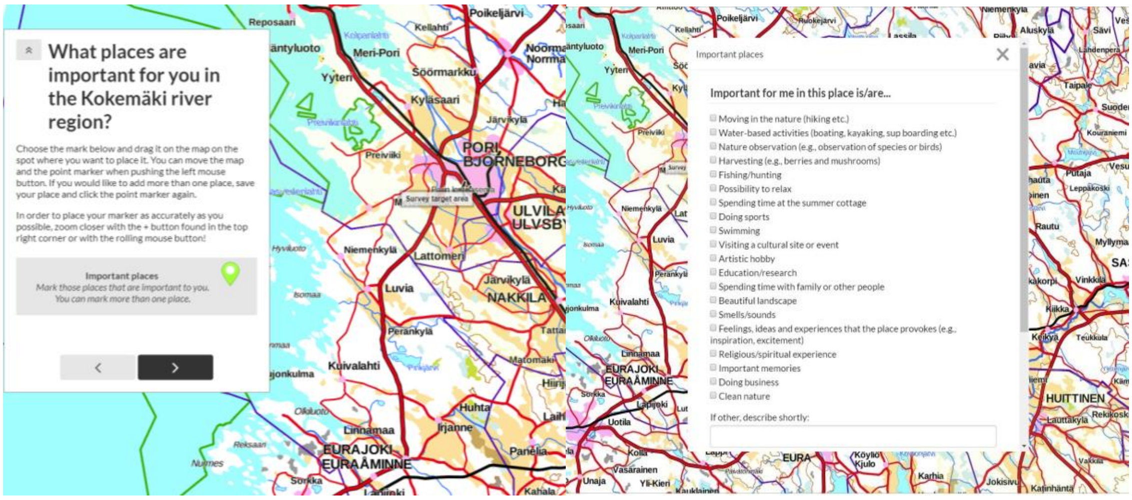
Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community

Figure 1. The Kokemäenjoki area in Southwest Finland.

2.2 Survey contents and data collection

This research was connected to the European Union–funded Interreg Central Baltic Programme 2014–2020 project SustainBaltic (https://sites.utu.fi/sustainbaltic/). Perceived ecosystem service benefits were collected through participatory mapping with an online survey (*https://app.maptionnaire.com/en/4424/*) operated on the Maptionnaire platform. Maptionnaire has been widely used for academic research in recent years

(Ernoul et al., 2018; Kahila et al., 2017; Kahila-Tani et al., 2019; Lamoureux & Fast, 2019). Developed as an online ‘do-it-yourself’ tool, Maptionnaire is an advanced example of PPGIS methodology and allows the mapping of environmental preferences, daily behaviours and knowledge and beliefs to collect spatial data (Kahila-Tani et al., 2019). The survey was open for the month of August 2018, and the survey link was shared via press release in municipalities, regional council actors, regional planners, nature conservation associations and social media (Facebook groups). Additionally, the study area was visited several times to distribute leaflets and cards promoting the survey. The survey targeted people who live in or nearby the Kokemäenjoki River Basin or who visit the area regularly. The main objective in the survey was to map people’s perceptions about the important places related to the CES benefits in their daily landscape (Chan et al., 2012; Haines-Young & Potschin, 2010). On the mapping page, respondents were able to mark where they live and their important places as data points (Figure 2, accompanied by the question, “What places are important for you in the Kokemäki region?”). Respondents were able to map an unlimited number of important places and choose related CES from a list of twenty items (e.g. moving in nature, hunting/fishing, doing sports etc.) (Fig. 2). The CES list was guided by ecosystem service frameworks and empirical studies applying participatory mapping (Haines-Young & Potschin, 2013; Mea, 2005; Vallés-Planells et al., 2014) and were adjusted to the local landscape context. Non-spatial pages in the survey included questions about the demographic characteristics of the respondents including e.g. gender, age and level of education. Data were collected from 198 respondents. In addition to pre-defined options, respondents were also able to describe in their own words why this place is important to them. Survey data were collected and mapped homes treated anonymously in the analysis.



What places are important for you in the Kokemäki river region?

Choose the mark below and drag it on the map on the spot where you want to place it. You can move the map and the point marker when pushing the left mouse button. If you would like to add more than one place, save your place and click the point marker again.

In order to place your marker as accurately as you possible, zoom closer with the + button found in the top right corner or with the rolling mouse button!

Important places
Mark those places that are important to you.
You can mark more than one place.

Important places

Important for me in this place is/are...

☐ Moving in the nature (hiking etc.)
☐ Water-based activities (boating, kayaking, sup boarding etc.)
☐ Nature observation (e.g., observation of species or birds)
☐ Harvesting (e.g., berries and mushrooms)
☐ Fishing/hunting
☐ Possibility to relax
☐ Spending time at the summer cottage
☐ Doing sports
☐ Swimming
☐ Visiting a cultural site or event
☐ Artistic hobby
☐ Education/research
☐ Spending time with family or other people
☐ Beautiful landscape
☐ Smells/sounds
☐ Feelings, ideas and experiences that the place provokes (e.g., inspiration, excitement)
☐ Religious/spiritual experience
☐ Important memories
☐ Doing business
☐ Clean nature

If other, describe shortly:

Figure 2. Screenshot from the survey showing the page for mapping important places and depicting the CES benefits linked to the mapped place.

2.3 Land cover overlay

The Densely Populated Areas dataset (*http://metatieto.ymparisto.fi:8080/geoportal/catalog/search/resource/details.page?uuid=%7B9085831B-8858-46E5-BAE1-3839CEC4CB52%7D*) and CLC 2018 (*http://metatieto.ymparisto.fi:8080/geoportal/catalog/search/resource/details.page?uuid=%7B26EEEBBB-FB5C-4045-B6DF-439F9B7D5C46%7D*) were downloaded from the Finnish Environmental Institute open web service. The Density Populated Areas dataset was used to distinguish mapped places between rural and urban areas. Based on CLC data, the Kokemäenjoki area was divided into four infrastructure types, which differ from each other in terms of their landscape characteristics and human activities. CLC was reclassified into four components: grey infrastructure (urban fabric, industrial, commercial and transport units, mine, dump and construction sites, CLC classes 111-133, 142), green infrastructure (forest areas, shrub and/or herbaceous vegetation associations and urban green areas, CLC classes 141, 244–324 and 333), yellow infrastructure (arable lands, permanent crops, pastures and heterogeneous agricultural areas, CLC classes 211–

243, 331, 332, 334 and 335) and blue infrastructure (inland wetlands, inland waters and marine waters, CLC classes 411–523). We overlaid the respondents' important places to this base map with further distinction between urban and rural areas to study the relation between the landscape structure and perceived ecosystem services in both urban and rural areas. All spatial analyses were done using ArcGIS Pro (Esri, 2018).

2.4 Spatial patterns of CES

We created kernel density maps for both urban and rural ecosystem services to visualise their spatial patterns and hot spots (Silverman, 1986). We applied 'expected mean distance' to use it for kernel density estimation as a radius. The Average Nearest Neighbor tool was used to measure the distance between each important point centroid and its nearest neighbor's location. The tool averages all these nearest neighbor distances and shows that they are clustered. The Nearest Neighbor Index is expressed as the ratio of the Observed Mean Distance to the Expected Mean Distance. The expected distance is the average distance between neighbours in a hypothetical random distribution. If the index is less than 1, the pattern exhibits clustering; if greater than 1, the trend is towards dispersion or competition (Scott & Janikas, 2009; ArcGIS, 2020). To use the same radius for both urban and rural area density, we used the average value (urban value+rural value/2) of the Expected Mean Distance for urban and rural, i.e. 2000-metre radius.

2.5 Statistical analysis of CES

Respondents' profiles were analysed in SPSS 26 (IBM, 2019) through descriptive analyses on age, gender and education. Perceived CES benefits were analysed by cross-tabulation, chi square statistic and standardised residuals to examine the CES distribution on each infrastructure's type in both urban and rural areas. We used cross tabulations to compare the mapped CES benefits (categorical variables) with the urban and rural areas and each infrastructure type. Standardised residuals were calculated to identify whether the number of CES points differed significantly from the expected number of points in both urban and rural and each infrastructure type. Expected counts are the projected point frequencies in each infrastructure type if the null hypothesis (h0) is true (i.e. there is no association between CES in both urban and rural and infrastructure types). We further used the chi-square test to test whether mapped CES benefits differed significantly between urban and rural areas and between different infrastructure types, respectively. A value of 0.05 was used as a limit of statistical significance.

3. Results

3.1 Respondents' profile

Women (50.3%) and men (48.7%) were nearly equally represented among the survey respondents (n=198). Further, 26.8% of respondents have a university or higher education degree, and 14.1% have post-secondary education degrees. There are 8% of respondents younger than 30 years, 64% between ages 30 and 59, and 28% are 60 years or older (n=188) (Table 1). Three respondents defined neither age nor gender. The answers to the question 'Where do you live?' were limited; 14 respondents indicated that they live in rural areas and 33 in urban areas.

Table 1 Subdivisions of respondents by age group and gender

Age groups	**Respondents**	
	Female	**Male**
<18	1	1
18–25	3	5
26–35	7	15
36–45	20	16
46–55	28	27
56–65	26	18
66<	12	9
Non-defined	2	5
Total	99	96

3.2 Infrastructure types in rural and urban areas and the spatial distribution of mapped important places

For the whole study area, the biggest infrastructure type is green, with 49% (1,387 km^2). For urban areas, the biggest infrastructure type is grey, with 45% (12,874.95 km^2) of the whole urban area. For rural area, the green infrastructure is biggest, with 49% (14,019.39 km^2) (Figure 3).

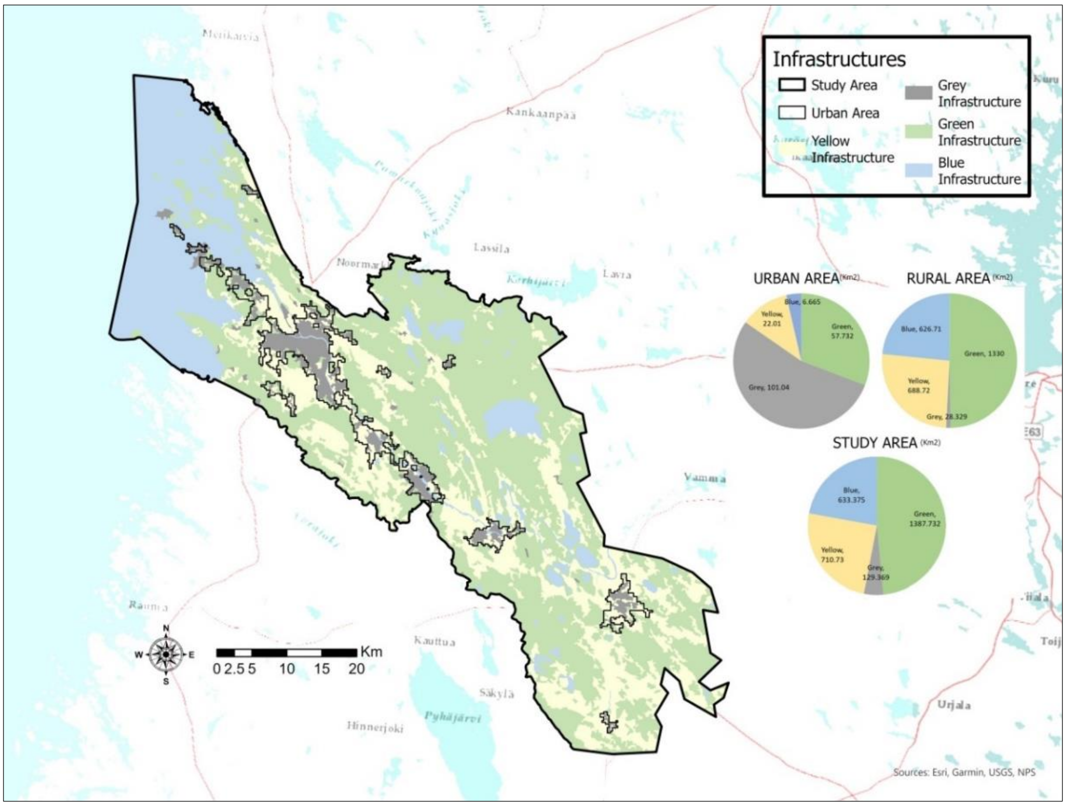


Figure 3. Four types of infrastructure in urban and rural areas in the Kokemäenjoki area.

The respondents mapped 448 important places in total in the study area (Fig. 4A). Rural areas (68.3%, 306 of mapped important places) (Fig. 4C) have the most prominent hotspots of mapped places compared to urban areas (31.7%, 142 of mapped important places) (Fig. 4B), where mapped CES benefits are mostly found in the grey infrastructure.

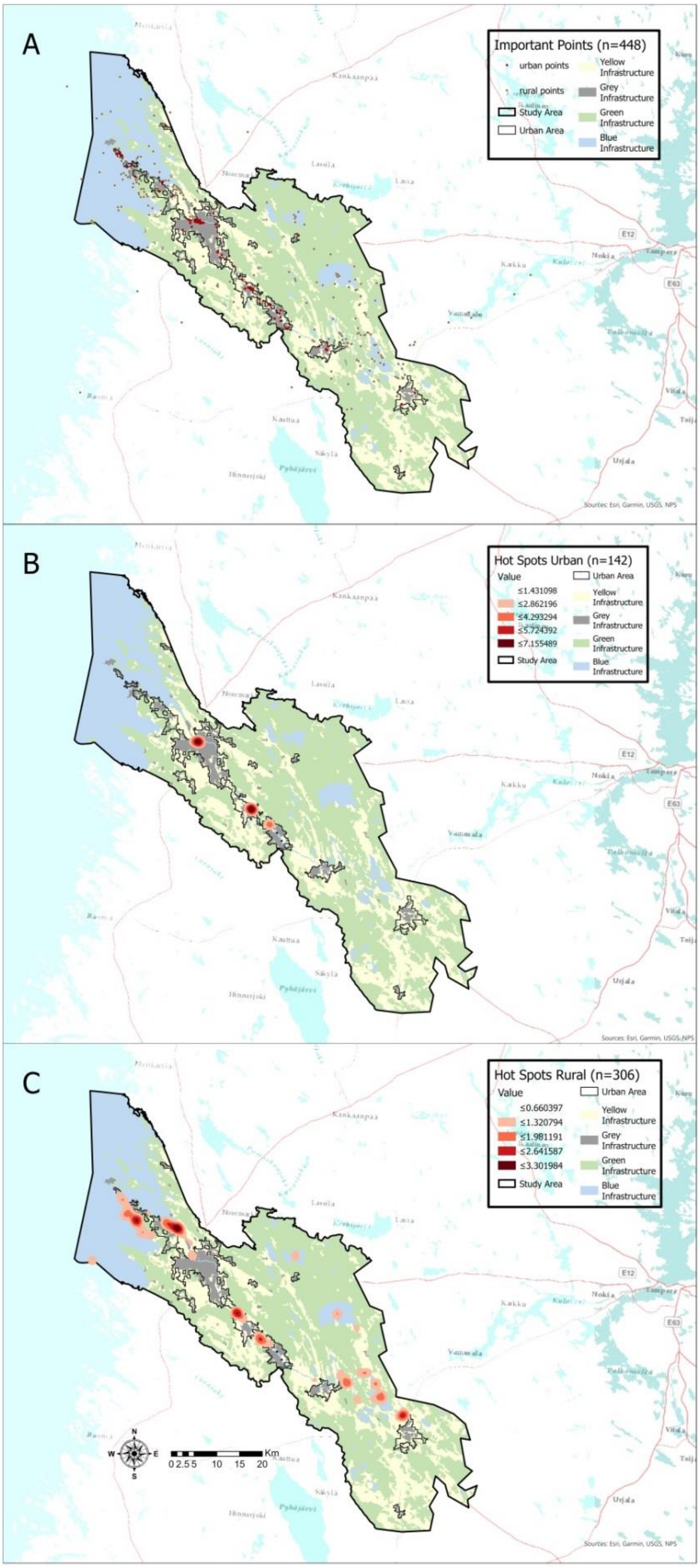


Figure 4. Spatial patterns of mapped important places in the Kokemäenjoki area. A) distribution of mapped important places, B) hot spots of mapped places in urban areas, and C) hot spots of mapped places in rural areas.

3.3 Perceived CES benefits in different infrastructures

In total, 1800 CES benefits were identified in connection to the 448 mapped important places. In relation to each mapped place, on average, 2.9 (SD 1.1) different CES benefits were identified. The mean number of perceived benefits was higher for green (4.22 benefits) and blue (4.07 benefits) infrastructures than for grey (3.89 benefits) and yellow (3.81 benefits). CES benefits that were perceived in relation to the mapped places are most commonly found in connection to the blue infrastructure (43%, 773 identified benefits). In rural areas, we found 47% (602 identified benefits) of CES benefits on blue infrastructure, 28% (359 identified benefits) on green infrastructure, 22% (279 identified benefits) on yellow infrastructure and 3% (46 identified benefits) on grey infrastructure (Figure 5). In urban areas, we found the majority of identified benefits on grey infrastructure at 48% (246), blue infrastructure had 33% (171), yellow had 13% (68), and green infrastructure had 6% (29) of identified benefits (Figure 6).

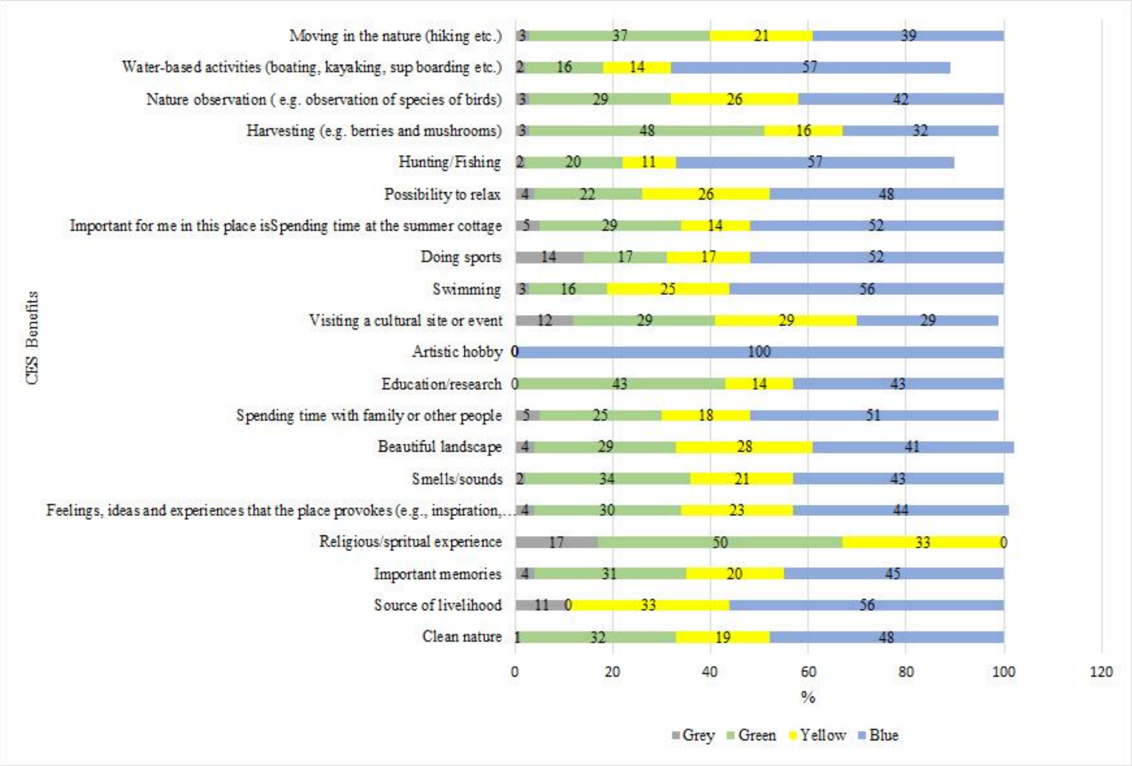


Figure 5. Perceived CES benefits on each infrastructure type in rural areas (%)

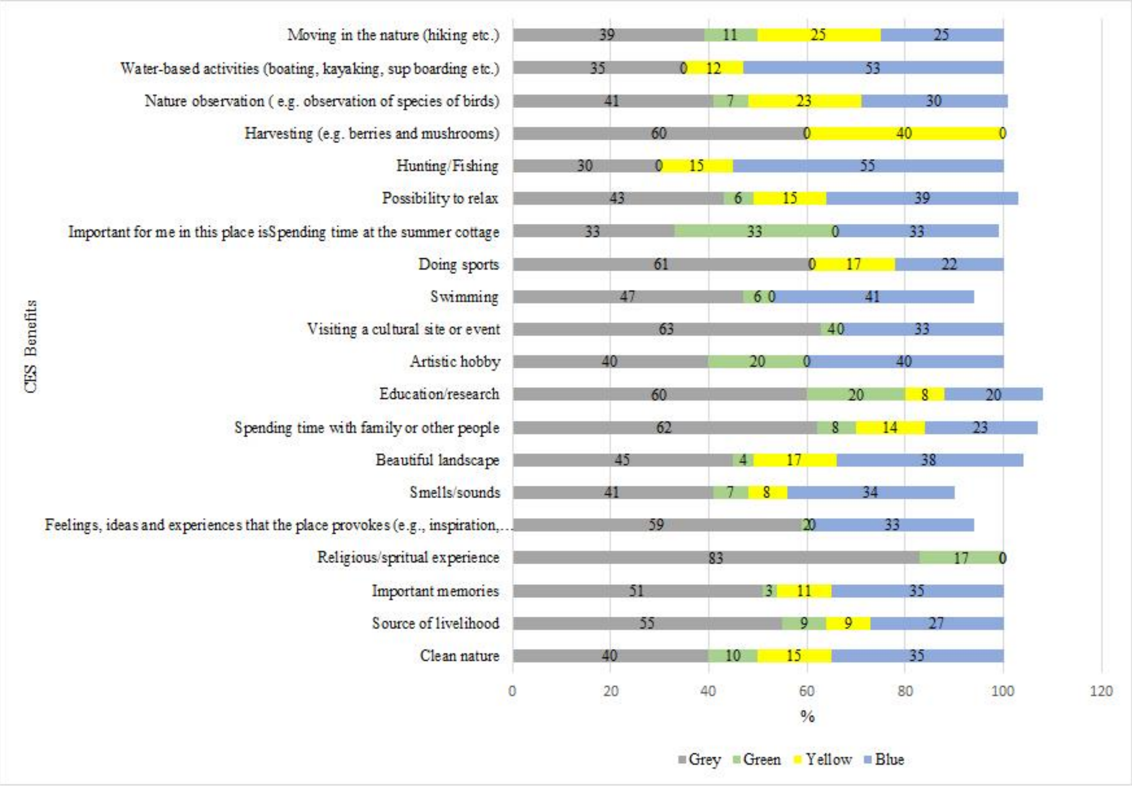


Figure 6. Perceived CES benefits on each infrastructure type in urban areas (%)

We found a statistically significant difference in CES perception among different infrastructures. Residents' preferences showed the dominance of blue infrastructure and statistically significant overrepresentation was observed for 8 of the 20 CES as being important to the participants (45.9%), namely moving in nature (35.5% of CES benefits in blue infrastructure), water-based activities (64.7%), nature observation (39.5%), hunting/fishing (64%), sport activities (40.4%), spending time with family or other people (41.7%), smells/sounds (41.4%), and clean nature (like clean air and fresh water) (Table 2).

Statistically significant differences in CES perception were related to other infrastructures as follows: Harvesting is carried out by 41.7% in green infrastructure (X2 (3, N = 36) = 11.4, p = .010). Visiting a cultural site or an event is preferred by 43.2% in grey infrastructure (X2 (3, N = 44) = 26, p = .000). A place was considered important in terms of religious/spiritual experiences by 50% in grey infrastructure (X2 (3, N = 12) = 14.6, p = .002).

Table 2. Share (%) of CES benefits perceived in connection to important places in grey, green, yellow and blue infrastructures and the p-values from chi-square tests. Significant associations are bolded.

Cultural Ecosystem Services (CES) Benefits	**Grey %**	**Green %**	**Yellow %**	**Blue %**	**p-value**
Moving in nature (hiking etc.)	12.3	30.4	21.7	**35.5**	**0.002**
Water-based activities (boating, kayaking, sup boarding etc.)	7.8	13.7	13.7	**64.7**	**0.000**
Nature observation (e.g. observation of species of birds)	10.5	24.5	25.5	**39.5**	**0.000**
Harvesting (e.g. berries and mushrooms)	11.1	**41.7**	19.4	27.8	**0.010**
Hunting/Fishing	9.3	14.7	12.0	**64.0**	**0.000**
Possibility to relax	16.2	16.8	22.5	44.5	0.372
Important for me in this place is spending time at the summer cottage	8.3	29.2	12.5	50.0	0.310
Doing sports	31.9	10.6	17.0	**40.4**	**0.013**
Swimming	18.4	12.2	18.4	51.0	0.301
Visiting a cultural site or event	**43.2**	13.6	11.4	31.8	**0.000**

Artistic hobby	25.0	12.5	0.0	62.5	0.345
Education/research	25.0	33.3	8.3	33.3	0.426
Spending time with family or other people	24.3	19.1	14.8	**41.7**	**0.017**
Beautiful landscape	17.0	20.0	23.0	40.0	0.907
Smells/sounds	10.5	27.8	20.3	**41.4**	**0.015**
Feelings, ideas and experiences that the place provokes (e.g. inspiration, excitement)	22.7	19.7	17.4	40.2	0.080
Religious/spiritual experience	**50.0**	33.3	16.7	0.00	**0.002**
Important memories	20.4	21.3	16.7	41.7	0.335
Source of livelihood	35.0	5.0	20.0	40.0	0.078
Clean nature	7.4	28.7	18.0	**45.9**	**0.000**

4. Discussion

4.1 CES benefits in urban and rural areas and land cover infrastructures

This study analysed the CES benefits along the urban–rural gradient of the Kokemäenjoki area in Southwest Finland. Participatory mapping and spatial analyses of CES have broadened the understanding of the connections between people and their landscape for both urban and rural areas. We have shown that perceptions of the landscape and their links to CES by people familiar with the Kokemäenjoki area can be spatially and statistically analysed. As only few studies have addressed ecosystem services along the urban–rural gradient, our findings are relevant for providing a better understanding of land cover and ecosystem services in terms of perceived CES benefits. Several studies have applied PPGIS in the contexts of CES and different land covers (Brown & Fagerholm, 2015; Brown & Hausner, 2017; Brown & Kyttä, 2014b). Additionally, our study analyses CES in relation to different infrastructures.

Our analyses are based on local and regional spatial data available for the Kokemäenjoki area. This study does not aim to provide accurate data for the relations between CES, infrastructures and different land cover types, e.g. urban and rural. Rather, the main objective of this study was to show whether there is a significant association between CES and infrastructures in rural and urban areas.

Our convenience sampling approach has the potential to cover all residents and visitors of the area who can be reached through the contacts we made (i.e. press release in municipalities, regional council actors, regional planners, nature conservation association and social media). Hence, the potential crowd is much larger than we reached. Nevertheless, the number of respondents allows our analysis to derive conclusions on the CES provided by the study area, and we find that even with this limited number of respondents, we can showcase the applicability of the ecosystem service concept in landscape planning. However, we acknowledge that a random sampling is an essential addition to this type of voluntary participation to reach more representative views (Brown et al., 2014).

Using the Corine 2018 data, we demonstrated what kind of land covers are related to the infrastructures and analysed the mapped perceptions of people concerning each of the four types of infrastructure. We found some comparable results in other studies that applied a similar methodology: Our findings proved that the analysed CES are spatially clustered to hotspots (Garcia-Martin et al., 2017; Plieninger et al., 2013) and confirmed that, in terms of providing CES, the importance of blue infrastructure (the sea and river areas) is related to the recreational and aesthetic benefits (Andersson et al., 2015; Grizzetti et al., 2016; Haase, 2015). The Kokemäenjoki area is a coastal site with some riverside populated centres, and therefore, people perceive many CES benefits particularly in relation to the water areas in both urban and rural areas. Attractive seashore and closeness to the sea together with the settlement and several historical places located along the river are major factors in why many important places are related to the blue infrastructure. Green and yellow infrastructures are related to active and passive recreational benefits, like doing sports and observing nature. This result is also similar to related studies (Kabisch & Haase, 2014; Mell, 2010). On the other hand, it is interesting that grey infrastructure is related to spiritual benefits, which could be due to the existence of historical places along the river that are close to the major settlements. At this point, this study showed that grey infrastructures are interesting in some respects but poor or dangerous for nature if not combined with other types of infrastructures in terms of the ecosystems' sustainability.

It is clearly seen that blue infrastructure is significantly different than the other infrastructure types in terms of CES benefits. In rural areas, blue infrastructure provides more CES than the other infrastructures, and the most provided CES in blue infrastructure is 'artistic hobby' (hobbies related to art, such as painting, drawing, sketching, making sculptures, writing poetry, dancing etc.). In urban areas, grey infrastructure provides more CES than the other infrastructures, and the most provided CES benefits are 'religious/spiritual experiences'. Previous studies highlight the importance of green infrastructure and assume that green infrastructures produce more ecosystem services in both urban and rural areas (Di Marino et al., 2019; Lindley et al., 2018). However, we found that blue infrastructure produced more ecosystem services in this landscape where river and water elements are dominating in rural areas. Blue infrastructure was also significant in urban areas, although grey infrastructure was related to most CES benefits in urban areas related to the water elements, This may be unexpected because some studies (Dong et al., 2017; Svendsen et al., 2012; Tiwary & Kumar, 2014) indicate that green infrastructure in urban areas supports human well-being more than the other types of infrastructure. It could be true for provisioning, regulating or supporting ecosystem services; however, for CES like sense of place or spiritual values, grey infrastructure is more preferred than the other types of infrastructures based on the findings of our study.

The results showed that activities related to recreation and cultural values are the most perceived common values in both urban and rural areas and in different infrastructures. Perceived values are significantly related to the presence of water, green areas, and cultural heritage. However, respondents in urban and rural areas have their own values connected to the infrastructures in terms of their social and cultural characteristics (Garcia-Martin et al., 2017).

4.2 Implementation in landscape planning and management

The ecosystem service concept became more predominant over the last decade in landscape planning and management (Baró et al., 2017; De Groot et al., 2010; Frank et al., 2012). The spatial assessment of ecosystem services could support the landscape planning process towards sustainability. Additionally, analysing the infrastructures spatially can be a way to understand the natural environment and relations between social and ecological structures.

In Finland, ecosystem services are not embedded in the practical planning processes at a regional level (Niemelä et al., 2010; Rinne & Primmer, 2016). Therefore, the applicability of the ecosystem service concept was tested and discussed during the SustainBaltic project in order to define different values of blue-green environments like agricultural areas, forests and semi-natural areas, and water bodies. The recent literature is quite familiar with the ecosystem services concept, but there is a lack of information about the implementation of this concept into landscape planning and management. There are, however, few examples from Finland related to its practical implementation from recent years. Tammi et al. (2017) have discussed the challenges of ecosystem service concept implementation in their paper. They indicated that there is indeed a need to find a connection between knowledge of green and blue areas and ecosystem services hotspot areas. In our study, we aimed to find a relationship between CES benefits and different environments, which are called ‘infrastructures’ in this article. Our findings showed that different infrastructures provide CES benefits at different levels.

The SustainBaltic project aimed to define the trends for sustainable marine and coastal tourism and to introduce the ecosystem service concept in regional land use planning. The project team found that increased communication and an exchange of local views and values on the prevailing land–sea interactions was one important result of the project.

Our findings confirmed that spatial assessment of the CES could be a key element in analysing spatially clustered urban and rural areas and their impact on landscapes (Hou et al., 2020). The ecosystem service concept in this context can be used as a platform to promote more holistic consideration of values in different environments and people's preferences towards them. The vagueness of the concept, however, was considered one of the biggest challenges in its practical application, and more explicit tools to describe different ecosystem services were encouraged. The need for new tools is particularly evident in CES assessments because these values are often linked to people's personal preferences rather than to explicit physical or ecological measures (Bagstad et al., 2017).

Cultural and natural landscape zones could be created from the CES hotspots in both urban and rural areas. They could be a way of measuring CES as part of the land use planning process and further of providing their sustainable management alongside other ecosystem services. Van Riper et al. (2017) emphasised the growing interest in PPGIS, particularly its ability to get knowledge from perceived values about biodiversity and its potential to mix social and ecological data that may inform landscape management decisions. Participatory mapping is also a helpful tool not only for measuring landscape attractiveness and identifying the elements that compromise the landscape value (De Vries et al., 2013) but also for building local communities' cultural shared scenarios (Assumma & Ventura, 2014).

In our study, we used PPGIS to link CES to explicit sites and infrastructures within the study area. This kind of data can provide significant insights into the features which are valued by the local people. These features need to be acknowledged in planning to preserve social and cultural characteristics of the planning area and to avoid potential conflicts between local stakeholders. If new activities are proposed for areas with high numbers of CES benefits, conflicts with local stakeholders may arise, and this may delay the entire planning process. Brown and Raymond (2014) evaluated three methods for identifying potential land use conflict using mapped place data as a function of the level of agreement on land use preferences and values of the place. If the PPGIS is collected before the actual planning process, the sites with high CES benefits can be identified in the early stages of the planning process and suitable actions can be taken either to avoid sites that are prone to conflicts or to start discussions with the local stakeholders about the impact mitigation.

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